REMARKS

The Office Action dated May 17, 2007 has been reviewed, and reconsideration of the application and allowance thereof are requested based on the following remarks.

The claims are amended herein solely for clarification purposes, so as to more fully comply with 35 USC 112.

A certified copy of the priority application will be submitted in due course.

Claims 1-3, 5, 10-12, 14, 19 and 20 stand rejected as obvious over Redshaw (GB 2 343 603) and Deering (U.S. Patent No. 6 624 823) under 35 USC §103. It is appreciated that Redshaw is directed to improving processing in shading 3-dimensional computer generated images, as is the instant invention. However, it is respectfully submitted that Redshaw seeks to improve such processing in an entirely different manner than the invention as defined in Claim 1.

Specifically, Redshaw is concerned with minimizing the total number of tiles or rectangular areas which will require processing. In this regard, Redshaw teaches, at page 7, lines 34-36 through page 8, lines 1-11, that it is only necessary to process the objects which intersect with a particular region or area (i.e. a tile). A triangle is utilized to represent the vertices of the object, and a bounding box is generated from this triangle and effectively defines a rectangular area within the screen which contains the object. The bounding box for the object is utilized to obtain a list of tiles located within the bounding box. This list of tiles is a subset of all the tiles within the screen and approximates the tiles which intersect with the object. Redshaw is thus concerned with determining a minimal set of tiles with which the triangle representing the object to be rendered crosses, and then only processes those tiles when rendering the object so as to improve processing efficiency. Thus, the purpose of the

invention disclosed in Redshaw is to reject tiles which are not necessary for rendering the object.

In contrast, the instant invention as defined in Claim 1 is directed to "a method for culling small objects in a system for shading 3-dimensional computer graphics images", including the step of "for each rectangular area, deriving a list of objects in the image which may be visible in that rectangular area". This step of deriving a list of objects includes the following steps:

"determining maximum and minimum values for each object in x and y directions;

for each object in the image, determining a bounding box from the maximum and minimum values of the x and y coordinates of the object;

determining a set of sampling points from the maximum and minimum values;

determining whether or not a bounding box surrounding the object covers any of the sampling points;

culling the object if the bounding box misses all the sampling points;

testing each sampling point against each edge of the object;

determining from the test performed by the testing step whether or not the object covers any sampling point; and

adding or rejecting the object from the list in dependence on the result of the determination."

The above-referenced object list-deriving steps are carried out so that small objects, which have no significant impact on the overall scene being rendered, are not rendered. The above steps embody a two-stage process which in the first stage will cull the object if the bounding box misses all of the sampling points, and in the second stage will test each sampling point against each edge of the object and determine

whether or not the object covers any sampling point, and then add or reject the object from the list as a result of this determination. This is completely different from the purpose of Redshaw's invention, which as understood is not concerned with rejecting objects from an object list corresponding to a rectangular area or tile and therefore avoiding having to render these objects as is the case with the instant invention, and instead is concerned with rejecting tiles which do not intersect with the object so as to avoid having to process these tiles at all.

In reviewing the Examiner's explanation of the instant rejection, it is noted that the Examiner points to various passages in Redshaw which allegedly teach the various steps involved in the "step of deriving a list of objects" recited in Claim 1 (see pages 3-5 of the Office Action). In this regard, with respect to the step of "culling the object if the bounding box misses all the sampling points" of Claim 1, the Examiner points to passages of Redshaw on page 2, lines 24-26 and on page 13, lines 9-11. The first of these passages reads "[a] further improvement on this method discards the tiles within a bounding box which do not actually contain the object to be rendered." As discussed above and as this passage evidences, Redshaw is teaching the discarding of tiles which do not contain the object to be rendered, and not the rejection of an object from a list of objects for each tile or rectangular area according to the present invention. Further, with respect to the second of these passages which reads "[i]n order to test whether a tile lies wholly on the outside of an edge, we need only test the point on that corner of the tile which is closest to the edge." Again, this passage is concerned with testing where a tile is in relation to a triangle edge for the purpose of determining whether the tile intersects with the object and should be part of the minimal set of tiles for processing purposes. It is evident that

these passages are not concerned with determining whether objects should be included on an object list for a rectangular area or tile for the purpose of eliminating rendering of small objects which have no significant impact on the overall scene being rendered.

Further, with respect to the step of "adding or rejecting the object from the list in dependence on the result of the determination" recited in Claim 1, the Examiner points to Redshaw at page 13, lines 28-31, which state "[f]or each edge of the triangle, each tile in the rectangular bounding box must be processed in this way to decide whether or not it should be excluded from the minimal set." This passage, contrary to the Examiner's interpretation, pertains to the exclusion of a tile from a minimal set of tiles which should undergo processing, and not to the exclusion of an object from an object list corresponding to a rectangular area or tile. Determining this minimal set of tiles for processing purposes is believed to be the teaching throughout Redshaw, and it is respectfully submitted that the Examiner is interpreting the passages of Redshaw in a manner which is inconsistent with the purpose and teachings of Redshaw.

The Examiner states that Redshaw does not explicitly teach the steps recited in Claim 1 which define "the step of deriving the list of objects", and cites Deering so as to allegedly cure this deficiency. It is submitted that the invention taught in Deering, like Redshaw, is concerned with determining a minimum number of bins or tiles which must be rendered (although Deering does this differently than Redshaw), and not with rejecting an object from an object list from a rectangular area or tile if the object is determined to be too small such that it would not have a significant impact on the overall scene being rendered as is the case with the present invention. As such, even if, for the sake of argument, the steps of Deershaw pointed out by the Examiner

were somehow combined with Redshaw, this would not result in a method which determines whether objects should be culled from an object list from a tile as recited in Claim 1, since neither reference is directed to this particular approach for improving processing. As such, the combination of Redshaw and Deering is not believed to result in the instant invention as defined in Claim 1, and thus the combination is believed improper.

Claims 2, 3, 5 and 19 depend upon what is believed to be an allowable Claim 1, are believed allowable therewith, and include additional features which further distinguish over Redshaw and Deering. For example, Claim 2 recites "determining whether or not the separation of the sampling points in the x and y directions exceeds the resolution of the display, and adding or rejecting the object from the list in dependence on the result of the determination." The Examiner states that Redshaw does not teach such features, and utilizes Deering to cure these deficiencies of Redshaw. In the passage cited by the Examiner, Deering teaches that samples may be filtered to form each pixel ordinate value, and that a sample buffer may be configured to support super-sampling, critical sampling, or sub-sampling with respect to pixel resolution. However, Deering does not disclose the step of determining whether or not the separation of the sampling points as defined in Claim 1 exceeds the resolution of the display, and adding or rejecting the object from the list depending on the result of this determination, because Deering as understood is not concerned with rejecting objects from object lists. The above filtering of the Deering invention is an image reconstruction filter used to upscale or downscale a sample image to target a particular resolution framebuffer, and thus is different from the small object culling of the present invention.

Independent Claim 10 is directed to an apparatus corresponding to the method of Claim 1, and Claim 10, as well as Claims 11-12, 14 and 20 are believed to be allowable over Redshaw and Deering for the same reasons as presented above relative to Claim 1.

Claims 6-7 and 15-16 stand rejected under 35 USC §103 as being obvious over Redshaw in view of Pearce (U.S. Patent No. 5 809 219).

Claim 6 is directed to a method for shading 3-dimensional computer graphics images comprising the steps of:

> "subdividing a display for an image into a plurality of rectangular areas;
>
> for each object in the image, determining a bounding box of rectangular areas into which the object may fall;
>
> testing edge information from each object against a consistent sample point in each rectangular area to determine whether or not the object falls into each of the rectangular areas in the bounding box; and
>
> inserting the object in an object list for a rectangular area in dependence of the result of the determination;
>
> wherein the step of testing edge information comprises the step of shifting the edge information by a predetermined amount in dependence on the orientation of each edge."

With respect to the step of "inserting the object in an object list for a rectangular area in dependence on the result of the determination" recited in Claim 6, the Examiner points to Redshaw at page 13, lines 28-31, which read "[f]or each edge of the triangle, each tile in the rectangular bounding box must be processed in this way to decide whether or not it should be excluded from the minimal set." As discussed above with respect to Claim 1, this passage, contrary to the Examiner's interpretation, pertains to the exclusion of a tile from a minimal set of tiles which should undergo processing, and not to any step which pertains to determining whether an

object should be inserted in an object list for a rectangular area or tile, as recited in Claim 6.

As for the step of "shifting the edge information by a predetermined amount in dependence of the orientation of each edge" recited in Claim 6, the Examiner points to Redshaw at page 13, lines 23-27, which read "[t]he comparison of the two values will indicate whether the point lies on the inside or outside of the edge. The interpretation of this result depends on the orientation of the edge as given in the table in Figure 9." The Examiner further explains that simpler mathematical operations would be achieved by shifting by a predetermined amount. However, at page 13, lines 28-31, Redshaw discloses that for each edge of the triangle, each tile in the rectangular bounding box, (not edge information from each object), is processed to decide whether or not the tile (not the object) should be excluded from the minimum set.

The Examiner states that Redshaw does not explicitly teach the step of "testing edge information from each object against a consistent sample point in each rectangular area to determine whether or not the object falls into each of the rectangular areas in the bounding box", and cites Pearce so as to allegedly cure this deficiency. In this regard, Pearce is directed to a method of simulating motion blur. Pearce, as understood, discloses motion vectors for the vertices in a three-vertex polygon that describe the motion of vertices as the three-vertex polygon moves from an initial to a final position. Pearce teaches a system and a method for simulating motion blur by identifying intersections of pixel sampling points with edges of moving polygons. The edges of the polygons of Pearce are moving as the polygons are moving, and thus Pearce does not pertain to shifting edge information of an object by a predetermined amount. On the contrary, the shifting step of Claim 6 is designed to allow the use of a consistent test corner for all edges rather than moving the

test point as a function of the edge, which results in lower cost implementations.

It is accordingly submitted that the invention taught in Pearce, as described above, is concerned with stationary sampling points with respect to moving polygons in order to produce a temporary anti-aliased motion blurred result. On the contrary, Claim 6 teaches testing edge information from each object against a consistent sample point, which testing includes shifting the edge information of the object depending on the orientation of each edge, so as to determine whether or not the object falls into each of the rectangular areas in the bounding box.

The Examiner explains that simplified mathematics is achieved by having a stationary sampling point rather than one that moves. The present invention uses the shifting step to achieve a safe calculation rather than to simplify the mathematics, as taught in the specification. Redshaw uses the expression of "y op mx+c", (where op is either less than or greater than), which differs from that used in the present invention, in that Redshaw requires additional special case testing for vertical edges where "m" approaches infinity. The present invention does not require such special case testing. The shifting of the present invention decreases the complexity of the hardware, for example, through removal of requirements for additional decisions made on a per-tile/per-edge basis. The present invention also allows for implementations using imprecise, that is, floating point mathematics to produce safe results. On the contrary, Redshaw as understood would require fully accurate mathematics in order not to accidentally leave some polygons out of tiles.

Furthermore, while Pearce teaches sampling an individual pixel against a triangle that is moving over a period of time in order to produce a temporally anti-aliased motion blurred result, it will be appreciated that the present invention does

not have the edges moving through time. Instead, the edges of the triangle are adjusted only once during an initiation phase with the amount of adjustment depending on the orientation of the edge. Then, a sampling of the shift triangle at the corner of the tiles determines whether the original triangle has any intersection with a tile.

As such, even if, for the sake of argument, the steps of Pearce pointed out by the Examiner were somehow combined with Redshaw, this would not result in a method which determines whether objects should be inserted in an object list for a rectangular area, as recited in Claim 6, since neither reference is directed to this feature. As such, the combination of Redshaw and Pearce is not believed to result in the instant invention as defined in Claim 6, and thus the combination is believed improper.

Claim 7 depends upon what is believed to be an allowable Claim 6, is believed allowable therewith, and includes additional features which further distinguish over Redshaw and Pearce. For example, Claim 7 recites, "the step of shifting edge information comprises shifting by either the vertical or horizontal dimension of a rectangular area." (emphasis added) The Examiner states that Redshaw does not disclose such a feature, and utilizes Pearce for this teaching. Pearce discloses that one or more polygons representing an object are matched to the x, y coordinates of sample points, and that the motion vectors describe the motion of the vertices as a 3-vertex polygon moves from an initial to a final position. Pearce's motion vectors do not shift edge information or specifically shift the dimension of a rectangular area. Further, Pearce illustrates a two-dimensional projection into x, y coordinates for the three-dimensional object rather than shift dimensions of a rectangular area.

Independent Claim 15 is directed to an apparatus corresponding to the method of Claim 6, and Claim 15 as well as dependent Claim 16 are believed to be allowable over

Redshaw and Pearce, for the same reasons as presented above relative to Claim 6.

Claims 8 and 17 stand rejected under 35 USC §103 as obvious over Redshaw in view of Pearce, and in further view of Vatti (U.S. Patent No. 5 265 210). Claim 8 recites that the shifting step is performed using a floating point calculation, and Claim 17 recites means corresponding to Claim 8. Redshaw and Pearce do not disclose such a feature of Claims 8 and 17, and the Examiner cites Vatti in this respect. While the present invention teaches that the shifting the edge information is performed with a floating point comparison, Vatti teaches the floating point addition of the values to the coordinates of the address of the just-plotted pixel. As such, Claims 8 and 17 are believed to be allowable over Redshaw, Pearce, and Vatti, alone or in combination with one another.

Claims 9 and 18 stand rejected under 35 USC §103 as being obvious over Redshaw in view of Pearce, and in further view of Venkataraman (U.S. Pub. No. 2002/0180729 A1). Claim 9 recites that the shifting step is performed with a safety margin whereby objects will be included in object lists for a rectangular area if the edge information falls close to a sampling point. Claim 18 discloses means corresponding to Claim 9. Redshaw and Pearce do not disclose such a feature, and the Examiner utilizes Venkataraman for this feature. Venkataraman teaches that the circularity can be tested by picking three points on the cross edge and then checking whether or not the sample points lie on a circle, within a tolerance. The shifting step of the present invention has a safety margin during processing. The Venkataraman invention, on the contrary, checks whether or not the sample points lie on a circle within a tolerance, rather than performing with a safety margin. As such, Claims 9 and 18 are believed to be patentably distinguishable over Redshaw, Pearce, and Venkataraman, alone or in combination with one another.

For the above reasons allowance of the instant application is respectfully requested.

Respectfully submitted,

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